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WASHINGTON CODES

BY E. G. BILHAM, B.SC., D.I.C.

At the 12th Conference of Directors held in Washington in September 1947, a large number of changes in the codes, specifications and procedures used in synoptic meteorology were recommended. It was also recommended that the new codes, specifications and procedures should come into use throughout the world on January 1, 1949. This date will therefore mark a red letter day in the history of synoptic meteorology. A " new order " will come into being which will profoundly affect almost every detail of the work of observers, plotters and forecasters in every part of the world. The purpose of this note is to give a brief outline of the principal changes, and to indicate the steps which are being taken in the Meteorological Office to prepare for the changes.

Index numbers of stations.—All stations will have new index numbers. The complete index number of every station will consist of five figures which may be written IIiii. The first two figures II represent a " block number ", which is generally the same for all stations in the same country, or (in the case of countries which cover a very large area) part of a country. For example, the block number for Great Britain and Ireland is 03. The last three figures iii represent the " national number " allotted to the station by the service concerned. In most forms of message only the national number will appear, but in collective messages groups of the form 999II will be used to indicate that the stations whose reports follow are in block II.

Forms of message.—Symbolic forms, either entirely new or different from those at present used in the Meteorological Office, will be brought into use for the following:—

Synoptic reports from land stations
Synoptic reports from ships (with " full ", " abbreviated " and " short " versions)
Abbreviated reports for aviation
Reports of sudden changes (MMMMM and BBBBB)
Upper air reports
CLIMAT messages

Reports from transport aircraft
Route and flight forecasts
Terminal and area forecasts

Minor modifications have also been made in the pilot-balloon code. The Combined Analysis Code (C.A.C.) has been adopted without substantial change under the name International Analysis Code (I.A.C.) with a shortened version for marine use, known as I.A.C. FLEET. The code known as CAW-C will continue in use for reporting observations made on meteorological reconnaissance flights.

Changes will also be made in many of the tables of specifications used for coding the various elements included in the messages. Those which affect the synoptic code are briefly referred to below.

New code for synoptic reports.—In view of its special interest, and its importance as the basic form from which other codes used for surface reports are derived, we give here the symbolic form (SYNOP) of the Washington Code for synoptic reports from land stations.

$$\text{(999II)} \quad \text{iii}T_dT_d \quad \text{Nddff} \quad \text{VVwwW} \quad \text{PPPTT} \quad N_hC_LhC_MC_H$$
$$\text{(6japp)} \quad \text{(7RRjj)} \quad (8N_sCh_sh_s) \quad (9S_pS_ps_ps_p)$$

The first five groups are " universal " groups, that is to say they will always appear in the message. The groups in brackets, each of which begins with a different indicator figure, are " drop-out " groups the use of which is governed either by regional agreements or by meteorological circumstances. In the European Region, the 6-group which contains the barometric characteristic and tendency will be obligatory, and the 7-group will be used at 0600 G.M.T. to report night rainfall and night minimum temperature, and at 1800 G.M.T. to report day rainfall and day maximum temperature. The 8-group gives additional details of cloud layers significant for aviation and drops out when there is no cloud of amount more than a trace below 20,000 ft. The 9-group is used to report special phenomena and to amplify the details of present and past weather.

Meanings of symbols.—In the following list changes in specifications or practice are indicated in italics

iii = Station national number (*new series*).
T_dT_d = Dew point (for temperatures below freezing point this is the temperature of saturation *over supercooled water*).

N = Total amount of cloud *in oktas* (*eighths*).
dd = Surface wind direction *to nearest ten degrees* (*i.e. scale* 01–36).
ff = Surface wind speed *in knots*.

VV = Horizontal visibility—*new scale, over most of the range the code number being equal to the visual range in furlongs* (200 *m.*)
ww = Present weather (*revised code*).
W = Past weather.

PPP = Pressure at mean sea level in millibars and tenths (initial 9 or 10 omitted).
TT = Dry-bulb temperature.

N_h = Amount *in oktas* of cloud the height of which is given by h.
C_L = Form of low cloud (*revised code*).
h = Height of low cloud.
C_M = Form of medium cloud (*revised code*).
C_H = Form of high cloud (*revised code*).

j = Symbol agreed on a regional basis—in the European Region state of ground E (*revised code*) is reported at 0600 and 1800 and a_x, detailed characteristics of barograph trace (*an entirely new code*), at other synoptic hours.
a = Characteristic of tendency.
pp = Barometric tendency in *tenths* of millibars.

RR = Rainfall (0600–1800 and 1800–0600 G.M.T. in European Region).
jj = Symbol agreed on a regional basis—in the European Region *minimum temperature* (1800–0600) at 0600, *maximum temperature* (0600–1800) at 1800.

N_s = Amount *in oktas* of significant cloud.
C = Type of significant cloud.
h_sh_s = Height of base of significant cloud—over most of the range h_sh_s is height in *hundreds of feet*.

$S_PS_Ps_ps_p$ = *Special phenomena and amplifying details of past and present weather.*

The ship's code is basically similar to the land code, the first group $iiiT_dT_d$ being replaced by the usual time and position groups $YQL_aL_aL_a$ $L_oL_oL_oGG$ and the 6-group being changed to d_sv_sapp, where d_s and v_s give the ship's course and speed. There is an additional drop-out group $oT_sT_sT_dT_d$ for reporting sea temperature and dew point and a group 1d $d_wP_wH_w$ for reporting the direction, period and height of waves, replacing the old sea-and-swell group. Provision is also made for reports of ice conditions. British selected merchant ships will not use the 8-group and the 9-group but these groups will appear in reports from ocean weather ships.

New charts.—A new series of plotting charts will be introduced, printed in light ochre and pale blue, the colours recommended in a Washington resolution. Specimens have already been tried at selected offices, most of which preferred the new ochre colouring to the familiar green. On the new charts the station numbers will be over-printed in light blue with the block boundaries indicated by pecked lines and the block numbers printed in a small square near the middle of each block.

New and revised publications.—Full details of the new codes and procedures will be set out in a new publication called " Handbook of weather messages, codes and specifications ". The Handbook will be issued in three parts. Part I will contain the transmission schedules of all weather messages emanating from Great Britain, Malta, Gibraltar, the Middle East and the British Zone of Germany, together with the index numbers, heights and co-ordinates of stations appearing in the transmissions. Part II will give

the codes and specifications in full detail. Part III will contain instructions for coding, decoding, plotting and recording, together with new humidity tables. The old *Pocket Register* (Form 2003) will be replaced by a new *Daily Register* of foolscap size (Form 2050) in which the columns are arranged in the same order as the elements in the synoptic message. At the same time a pocket-size pad will be introduced for the initial entry of observations so that the Register does not have to be taken out of doors when making the outdoor observations. New editions of " Cloud forms " and of the " Instructions for the preparation of weather maps " (Form 2459) will also be issued. Observers at auxiliary stations will be provided with new versions of the *Register of Observations* (Form 2611) and "Abbreviated weather reports for aviation " (Form 2612). All other forms, etc., related to synoptic procedure will be similarly revised.

Concluding note.—It will be clear from the foregoing that a very special effort will be called for by everyone associated with the synoptic weather service when the " new order " is brought into being. The Directors and technical experts of all countries laboured unremittingly over a period of three years to solve the problems presented by the code situation at the end of the war. Those responsible for the implementation of the Washington resolutions have done all that foresight and planning can do to make the changeover as easy as possible. It now remains for meteorologists and assistants of all grades to give their whole-hearted co-operation in carrying out this great and far-reaching operation. We are perhaps all inclined to look for demerits rather than merits in things which are new and strange, but there is little doubt that as we settle down under the new procedures we shall appreciate the unification that has been achieved and find that we can do our work better and with more satisfaction with these brave new tools.

INTERNATIONAL METEOROLOGICAL ORGANIZATION

Telecommunications Sub-Commission Meeting in London, July 1948

BY C. V. OCKENDEN, B.SC.

An account of the International Meteorological Organization (I.M.O.) was published in the *Meteorological Magazine* for March 1947 and reference was made to the recent Conference of Directors in Washington in the issues for January and February 1948. Resolution No. 220 of the Washington Conference directed that each I.M.O. Regional Commission should establish a Sub-Commission charged with the duties of organising the meteorological telecommunications within the region, co-ordinating transmissions between adjacent regions and compiling information for insertion in the appropriate publications of I.M.O. After the meeting in Paris last April of the European Commission, the President invited all countries in Europe (Region VI) to nominate a representative to serve on the Sub-Commission which was summoned to meet in July.

Meetings were held from July 5 to July 10 at Lancaster House, St. James', London, and delegates from about a dozen countries were welcomed by the Secretary of State for Air, Mr. Henderson, in the large Conference Room

(this was originally one of the state rooms whose splendours were described by Disraeli as being " not unworthy of Vicanza "). The Secretary of State remarked that the science of meteorology cannot be limited by boundaries of political or natural geography, and he stressed the fact that without first-rate communication facilities it would be impossible to construct adequately and promptly the many charts now required not only for day-to-day forecasting but also for forecasting research.

The work of the Sub-Commission consisted to a large extent in examining problems to which only partial and provisional solutions had been found at previous Regional and International Civil Aviation Organization (I.C.A.O.) meetings. M. Leclercq (France) was elected Chairman and two working panels were formed, one under the chairmanship of Mr. Ockenden (United Kingdom) to deal with the more technical items on the agenda, and the other under the chairmanship of M. Godart (Belgium) to study items concerning (*a*) the preparation of handbooks, and (*b*) changes in procedure which would be necessary as a result of recent I.M.O. decisions and the introduction of new codes in January next. The Conference did not learn until the second day that the Danish representative Dr. Lykke and his secretary, Mlle. Doellner, were passengers in the Swedish aircraft which was involved in the collision at Northolt on the previous Sunday. Many delegates felt that they had lost a personal friend in the tragic death of Dr. Lykke and a message of sympathy was sent to Copenhagen. It was also a matter of regret that delegates from U.S.S.R., Czechoslovakia, Hungary and Romania were unable to arrive for the discussions which included the formulation of schemes to extend the exchange of data by means of teleprinter circuits to central and eastern Europe. The western European meteorological teleprinter network has proved so successful that the setting-up of similar networks to cover the whole of Europe can only be a matter of time. As an interim measure plans have been laid for Norway, Sweden, Denmark, Poland, Czechoslovakia and Italy to be connected to the western network at suitable centres as soon as their internal teleprinter circuits are sufficiently developed.

An important decision was reached concerning the European terminal which should handle the exchange of data with North America. It was agreed that radioteleprinter working has now become sufficiently reliable to be adopted in preference to the much slower W/T channels, and it was recommended that, commencing July 1, 1949, Dunstable, England, should assume responsibility for the exchange of data with New York and for re-diffusing American data to other European countries both by W/T and teleprinter broadcasts. The Conference also considered that there should be a cable stand-by so that a skeleton exchange can be maintained in the unlikely event of all radio communication being interrupted by a radio " blackout ".

Other recommendations concerned the requirement for still further standardization of messages and procedure, the possible amalgamation of national W/T broadcasts from neighbouring small countries and the formation of a panel to study the international aspects of facsimile transmissions.

Delegates were invited by H.M. Government to a reception in the Air Ministry Air Council Room on one evening, and a visit was arranged to the Central Forecasting Office at Dunstable on the afternoon of July 8.

THE SEA-GOING METEOROLOGIST

BY A. H. GORDON, M.S. (Pasadena)

The accuracy and detail of all weather forecasts at present prepared in this country are very largely dependent on the receipt of routine information from the Atlantic Ocean. The overall efficiency of the meteorological service, as supplied to the B.B.C. and the press for issue to shipping and to the public and as supplied to the services and civil aviation, is thereby closely related to the quantity, quality and regularity of information received from the ocean to our west.

Before the war information received from the Atlantic was derived almost entirely from merchant ships which necessarily tended to concentrate on more or less fixed tracks thus leaving considerable blank areas such as to the west of Ireland and Scotland and to the south of Iceland and Greenland.

With the return of peace it was realised generally that the receipt of observations from ships pursuing courses along narrow sea lanes was not, in itself, sufficient measure to meet the superior and more accurate meteorological service required to supply post-war world aviation and other needs. Accordingly, it was decided by the International Civil Aviation Organization supported by the International Meteorological Organization to recommend the establishment of ocean weather ships at fixed positions on the oceans from whence they would transmit at regular agreed intervals full surface and upper air meteorological information. It is emphasised that this does not in any way belittle the value of observations from merchant ships but supplements them in areas which would otherwise be devoid of any information whatsoever.

Great Britain's contribution to this international plan has been the establishment of four ocean weather ships to maintain between them a continuous watch at stations 53°50′N. 18°40′W. and 60°N.20°W., commonly known as stations JIG and ITEM, in the North Atlantic.

There are two great advantages in obtaining in this way information additional to that obtained from normal shipping. First, the information is derived from positions well outside the normal shipping lanes and thus covers what would otherwise be a blank spot. Secondly, since the ship is stationary, the sequence of weather at that position can be supplied to the meteorologist ashore. A knowledge of the weather sequence at a given station on the synoptic chart is an essential factor in chart analysis and therefore in the accuracy of any forecasts subsequently prepared. This element of sequence does not possess the same value when obtained from a moving ship. In particular the accuracy of the barometric tendency is reduced even though allowance is made for the ship's movement across the isobars.

Apart from the supply of surface observations from these fixed positions in the eastern Atlantic the establishment of the ocean weather ships has provided facilities for the undertaking of upper air observations. It is clearly impracticable for this type of work to be undertaken by other ships during the course of their normal voyages; thus the ocean weather ships provide the sole means by which the supply of this most important information can be effected.

The sea-going meteorologist plays an essential part in the highly complex organization of the meteorological service. His observations are awaited with great expectancy ashore. On the majority of occasions these observations

are, without exception, the most important on the chart and quite far-reaching decisions involving all manner of service exercises and flights throughout the entire country may depend upon the information they contain. The issue of gale warnings which results in the taking of widespread precautionary measures for the safety of life and property both at sea and on land cannot function efficiently unless based on reliable information from the vital ocean areas through which storms are moving or in which they are developing.

In addition to partaking in the routine surface and upper air observational work the sea-going meteorologist has the opportunity of investigating a number of problems relating to instrumental and synoptic problems at sea. Such investigations present a new field which has hitherto only been touched upon lightly.

The ocean weather ships, however, provide the material facilities for studying the various aspects of marine meteorology in the field so that considerable contributions can be made to our knowledge of this subject and of meteorological science as a whole.

The boundary conditions governing the physical processes of the atmosphere are considerably different over the oceans from over land. Surface friction, heat exchange and lack of topographical influences are all factors which make meteorological conditions different at sea from over land. There is a great deal of interesting and useful research to be done by the sea-going meteorologist during the course of his periodic expeditions into the heart of the Atlantic.

If the centre of a depression should pass over the ship's position opportunity is offered for first-hand eye-witness studies to be made by the meteorologist of certain features in nature to which it has not been possible in the past to devote similar specialist attention. Likewise, if any unusual local phenomenon such as a waterspout is observed nearby it might be approached and a special close examination made under circumstances which it has not been possible to provide previously.

On the more practical side the sea-going meteorologist may be interested in such matters as the design, accuracy and exposure of the meteorological instruments aboard the ship, or he may be an enthusiast for the technical aspects of the radar and radio-sonde equipment.

A word on the lighter side might be included. There are, of course, few healthier pursuits than life aboard ship at sea. Cigarettes and other goods are obtainable at duty-free prices. Recreation in off-duty hours can at times be taken in the form of rubber-dinghy rowing while even races can be indulged in. There are possibilities of swimming in the summer months while sunbathing may be enjoyed on deck when the weather permits. Cinema shows and bridge provide indoor recreation. Attempts at deep-sea fishing have been made but with little success so far. There is a good library and radio receivers are available for entertainment reception. There should be little time during the 28-day voyage which cannot be fully and interestingly utilised. And then, at the end of their period on station, there is the exhilaration of being homeward bound—the thrill of which to a seaman never seems to lessen—coupled with the realization of a useful job well done. And at the end of the voyage 15 days leave provides a welcome and well earned diversion.

Thus, to the meteorologist who is keen to undertake a new and somewhat unusual task that is away from the normal run, combining work of the highest value and importance with rather different recreational opportunities, then the job of sea-going meteorologist aboard an ocean weather ship is the sort of change that should suit him best.

THE DEVELOPMENT OF THE METEOROLOGICAL OFFICE RADAR REFLECTOR, MK. II B

BY O. M. ASHFORD, B.SC., A.INST.P. AND H. J. FERRER, B.SC.

Introduction.—Since the introduction of the radar method of measuring upper winds,* development work has been directed to improving the radar reflectors. This report describes the work to date which has resulted in the introduction of the Mk. II B reflector.

Requirements.—A radar reflector for use with the GL Mk. III (A.A. Radar No. 3 Mk. 2/4) set should meet the following requirements:—

(*a*) It must be an efficient reflector of radio waves of 10-cm. wave-length.
(*b*) The aerodynamic drag must be as low as possible.
(*c*) The weight must be as low as possible.
(*d*) The assembly procedure must be straightforward, requiring no ancillary equipment.
(*e*) The dimensions when packed for storage must be as small as possible.
(*f*) The cost must be as low as possible.

The most serious disadvantages of the existing paper reflectors fall under headings (*b*) and (*e*). The storage dimensions and aerodynamic drag are so large that it would be quite impracticable to handle a similar reflector of larger size, which would be needed for extending the maximum obtainable range.

The ideal arrangement would be to have an electrically conducting balloon. Two alternatives were considered: to have the balloon coated with a metallic paint or to have the balloon fabric impregnated with an electrically conducting substance such as carbon. In both cases the chief difficulty was that as the balloon expanded (in a normal ascent its diameter increases from 6 ft. to 16 ft. or more) the electrical resistance of the balloon would increase beyond the allowable limits.

The next possibility would be to have the reflector inside the balloon. No experimental work was done on this because the bursting height of the balloon would be adversely affected by the attachments required to hold the reflector stretched in position. A reflector of sufficient rigidity in itself, yet capable of being passed through the balloon neck (internal diameter about 1 in.) would tend to be too expensive.

For 100-gm. balloons which expand to about 6-ft. diameter, a shroud reflector made of metallised nylon mesh has been proved satisfactory by the Admiralty. The area of a similar reflector for a 350-gm. or 500-gm. balloon would be about 50 sq. yd., and the cost would be prohibitive.

In view of these considerations it was concluded that the most hopeful line of attack would be to develop a corner reflector with the planes made of wire

* London, Meteorological Office, Measurement of upper winds by radar methods. London, 1944.

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I.M.O. EUROPEAN TELECOMMUNICATIONS SUB-COMMISSION

Mr. Arthur Henderson, Secretary of State for Air, opening the conference at Lancaster House

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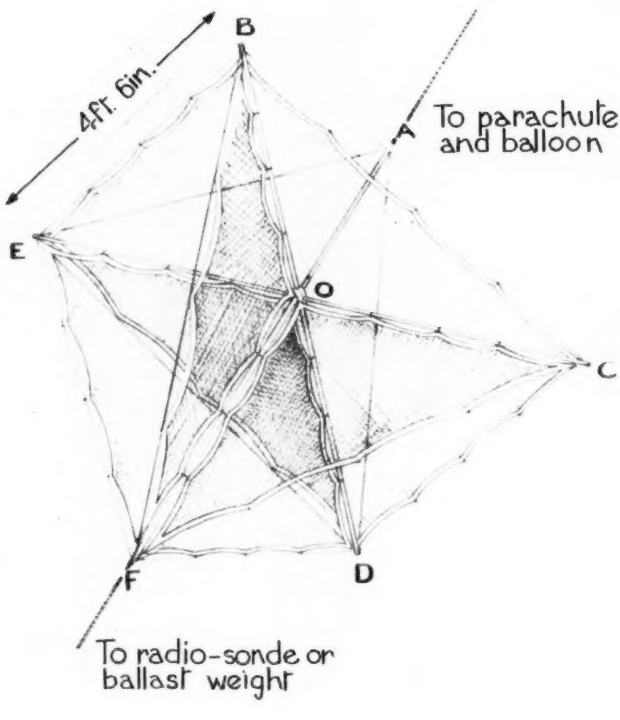

FIG. 1—MK. II B REFLECTOR

mesh or metallised nylon mesh. The chief difficulty with the wire mesh was to find a suitable knitting machine—a woven mesh would not lend itself so readily to being folded into a small pack and subsequently opened out to make a smooth taut plane. Some experiments have been made with knitted wire mesh but so far the results have not been very satisfactory.

Radar reflector Mk. II B.—The new reflector which is now in large-scale production is shown in Fig. 1. The square plane BCDE and the triangular planes BOF, COF, DOF and EOF are made of nylon mesh, approximately 5 meshes to the inch, impregnated with silver by the "sucalising" process. The electrical resistance between any two points on a plane 1 ft. apart is nowhere greater than 10 ohms. The planes are bound along the edges with a cambric tape and stretched on a framework of duralumin tubing. Additional support is provided by a number of bracing wires, EFC, BFD, EAC, BAD and BCDF, which may be brought to the required tension after assembly by rotating the rod AO. The rod AO is held in the final position by inserting a split pin through holes in the rod and the central boss at O. The side of the top square is 4 ft. 6 in. in length. When packed for transit, the dimensions are 40 in. × $2\frac{3}{4}$ in. × $1\frac{1}{2}$ in. compared with 42 in. × 42 in. × $\frac{5}{8}$ in. for the 3-ft. paper reflector. The reflector weighs 790 gm., only 30 gm. more than the 3-ft. reflector.

In spite of the increased dimensions, the aerodynamic drag of the Mk. IIB reflector is appreciably less than the 3-ft. paper reflector because of the mesh construction. This point is illustrated in Fig. 2, in which the rate of ascent is plotted as a function of the free lift for the Mk. IIB reflector and the 3-ft. paper reflector. "Free lift" is here defined as the weight the balloon will just lift in addition to the attached load.

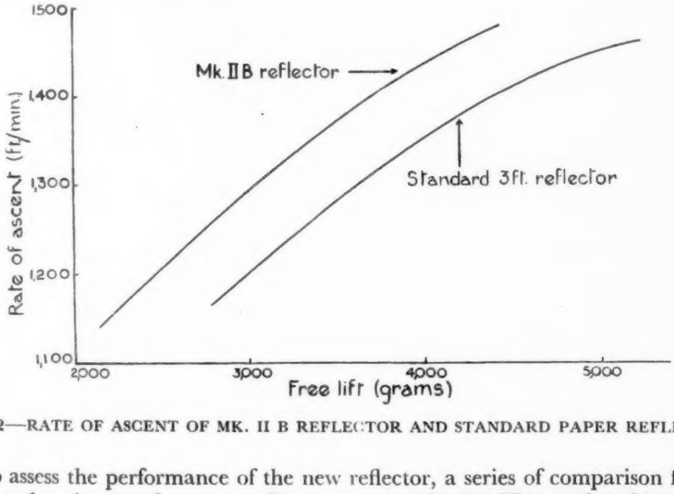

FIG. 2—RATE OF ASCENT OF MK. II B REFLECTOR AND STANDARD PAPER REFLECTOR

To assess the performance of the new reflector, a series of comparison flights was made using a 3-ft. paper reflector as a standard. The results of a typical flight are shown in Fig. 3, in which the mean signal/noise ratio is plotted against the slant range. The trials were made with a GL Mk. III set and the results given in Fig. 3 were obtained when the set was working at high efficiency.

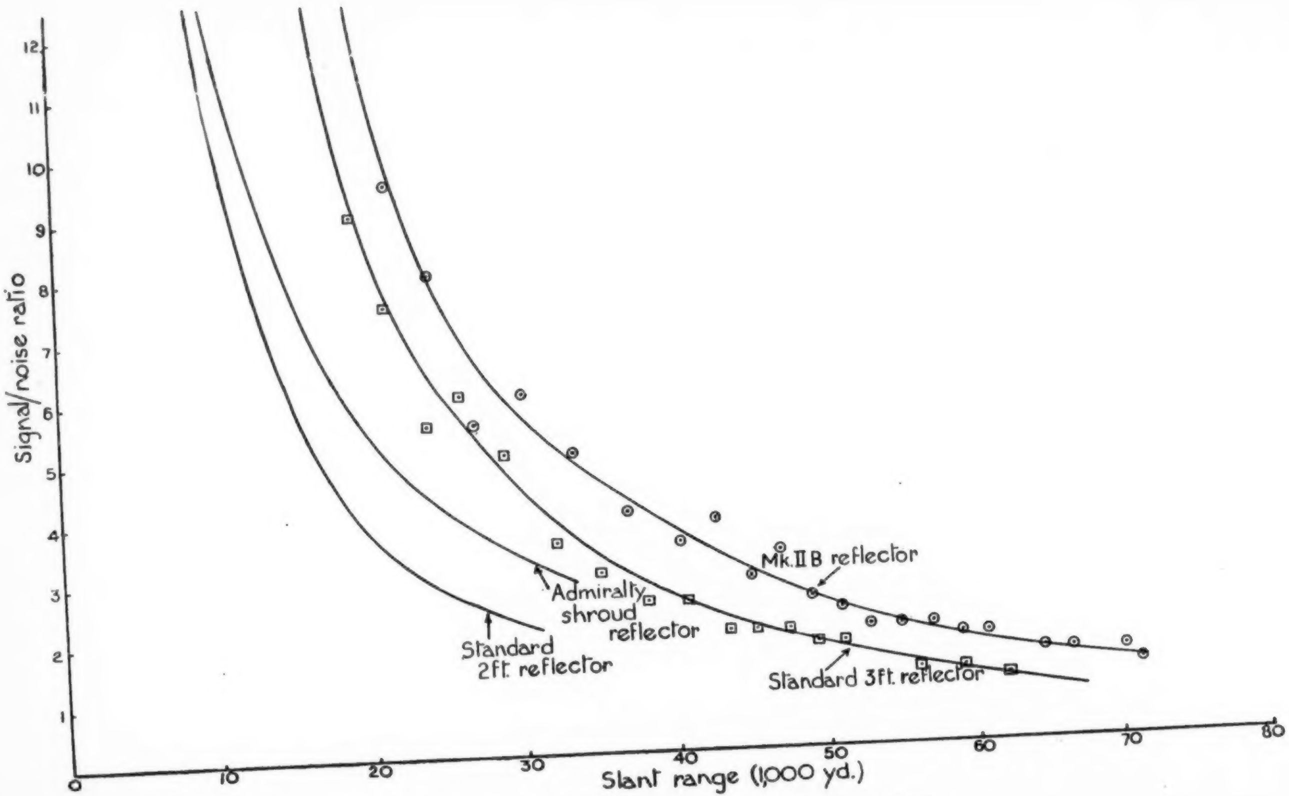

FIG. 3—SIGNAL/NOISE RATIO AT DIFFERENT RANGES

The curves in Fig. 3 for the 2-ft. paper reflector and the Admiralty "shroud" reflector are based on Figs. 3 and 4 of R.R.D.E. Report No. 311*. To allow for the dependence of the signal/noise ratio on the set efficiency and the method used for estimating its mean value, the R.R.D.E. results were brought to roughly the same standard as the other Fig. 3 curves by using the 3-ft. reflector as a standard of reference. Too much weight should not therefore be attached to the numerical values of signal/noise ratio given in Fig. 3, but the relative position of the various curves are considered to be fairly representative.

It will be seen that, although the Mk. IIB reflector is appreciably better than the 3-ft. paper reflector, the improvement is not so great as might have been expected (the range for a given signal/noise ratio should be proportional to the linear dimensions). This is partially due to the various planes not being electrically bonded. In the original Mk. IIB reflectors, the cambric tape was metallised and the triangles were therefore in direct electrical contact with the top square. Unfortunately the cost of metallising the tape was excessive and in the production model it is left plain. It is estimated that an improvement of 10 per cent. in the signal/noise ratio would be achieved by bonding the planes to each other.

The assembly of the Mk. IIB reflector is complicated by the necessity for having the tensioning wires. The efficiency of a corner reflector falls off very rapidly if the surfaces are not sensibly plane and if the angles differ by more than a degree or so from right angles. It was found that a good tension was essential for the mesh type of reflector and the present method is the simplest yet devised.

Conclusion.—The Mk. IIB reflector is much better than the older type as regards drag and storage dimensions and its performance is slightly better. Further improvement may be achieved by some method of electrically bonding the planes, and a simpler method of providing adequate tension is also desirable.

OFFICIAL PUBLICATIONS

The following publications have recently been issued:—

Annual Report of the Director of the Meteorological Office presented by the Meteorological Committee to the Secretary of State for Air for the year April 1, 1947, to March 31, 1948.

This report contains an account of the important progress made during the past year towards placing the Office on a peace-time basis.

The reorganization of the Office in accordance with the White Paper on the Government Scientific Service (Cmd. 6679) was almost completed. In view of the increased responsibilities of the Meteorological Office the Headquarters was strengthened and now includes a Principal Deputy Director, three Deputy Directors and nine Assistant Directors.

Various steps were taken to make the service provided by the Meteorological Office for the general public closer and more effective. Apart from the forecasts and warnings broadcast by the B.B.C. a system was introduced for providing the control offices of British Railways with advance notification of weather likely

*ALLWOOD, H. I. S. AND BEECHING, G. H.; The suitability of existing types of balloon-borne reflectors for the measurement of wind speeds by means of equipment Radar A.A., No. 3 Mk. 2/4. *R.R.D.E. Research Rep. Malvern, Worc.* No. 311, 1946.

to interfere with passenger and goods services. In another scheme arrangements were made to provide snow warnings to County Surveyors and Divisional Road Engineers throughout the country. Further measures to assist the national economy are under discussion with the Departments concerned.

Among the extensions of services for the Royal Air Force and civil aviation was the provision at Malta and Shaibah of facilities to enable over-flying aircraft to discuss the weather situation with the duty forecaster by radio-telephony.

The international scheme for the establishment of 13 weather stations in the North Atlantic is proceeding. The first British ocean weather ship took up her station in August 1947 and the remaining three were all commissioned by January 1948.

Certain Colonial Meteorological Services which came under Air Ministry control during the war were handed back to the local Governments. All necessary assistance was given to these and other Colonial Services to enable them to function efficiently.

The Meteorological Office took a leading part in the work of the International Meteorological Organization, the Director of the Office being President of the Organization throughout the year. Several members of the Office attended the meetings of the Organization held in Toronto and Washington at the end of the summer. To increase the status of the International Meteorological Organization it was agreed to replace it by a World Meteorological Organization supported by an intergovernmental convention.

Research work was undertaken on an extensive scale. It is formulated by the Meteorological Research Committee and carried out by the Office research organization. Of the research work performed may be mentioned:—

(*a*) an exhaustive study of the distribution of wind all over the world up to the heights of over 45,000 ft. necessary for air-route planning,

(*b*) other research for aviation concerned with the means of enabling aircraft to avoid turbulent clouds, means of reducing the risks of ice accretion, and the navigational technique known as pressure-pattern flying,

(*c*) forecasting research using circumpolar weather maps and further study of the physical principles of the atmosphere (detailed studies of errors in routine forecasts were made focussing attention on the inadequacies of current knowledge),

(*d*) research for agriculture on the meteorology of the air near the ground especially in connexion with its water-vapour content,

(*e*) in the field of meteorological instruments work on balloons to carry instruments to a height of 100,000 ft. and on instrumental means of measuring cloud height in daylight and visibility at night.

PROFESSIONAL NOTES

No. 91. *The vertical gradient of wind velocity in the lowest layers of the atmosphere.* By N. K. Johnson, K.C.B., D.Sc.

This paper contains almost unchanged two Porton reports dated February 14, 1923, and March 19, 1925.

The first report shows that in temperature-lapse conditions the wind velocity in the lowest 3 metres of the atmosphere can be expressed in the form

$$u = A \log_{10}(z + c) + B,$$

where u is wind velocity, z is height, and A, B and c are constants. This logarithmic law was also found to hold up to heights of 305 m. above the ground.

In temperature-inversion conditions the velocity gradient is much steeper than when temperature decreases with height and approximates to the logarithmic law, although not as closely as in the case of a temperature lapse.

The second report is an endeavour to fit a more tractable expression, of the form $u = Bz^m$, than the logarithmic law above, which was found to be rather inconvenient mathematically. Hourly values from autographic records made by three electrical cup anemometers at 5·0 m., 13·4 m. and 21·7 m. are compared with readings taken with delicate air meters (such as were used in experiments for the first report), and the two were found to be in satisfactory agreement. The value of m was found to vary from 0·08 with a temperature lapse of $-0{\cdot}1°$F./m. to 0·26 with a temperature inversion of $+0{\cdot}18°$F./m.

In a given temperature gradient, the value of m is found to be independent of the wind velocity provided the latter exceeds 6 m./sec. Below this wind velocity the value of m tends to increase. It is suggested that this result is due to the reduced eddy viscosity at low wind velocities.

LETTERS TO THE EDITOR

High pilot-balloon ascents at Oakes Field, Nassau, Bahamas

In the November 1947 issue of the *Meteorological Magazine*, Mr. J. C. W. Wickham commented on high pilot-balloon ascents made at Piarco, Trinidad. The following notes on high pilot-balloon ascents made at Nassau, Bahamas, during the period October 1946 to December 1947 might prove of interest in so far as Nassau, like Piarco, also lies in a maritime air mass.

Pilot-balloon ascents are made four times daily, as near as possible to 2200, 0400, 1000 and 1600 E.S.T. (0300, 0900, 1500 and 2100 G.M.T.), the results being included in the United States scheduled broadcast of synoptic and upper air data. Unless the occasion warrants it, e.g. during the presence of a hurricane, there is little divergence from these times, and it is frequently not possible to utilise the best conditions for balloon ascents.

The location of the station at Oakes Field airport is not too favourable for daylight ascents, since it lies on a low ridge on the northern side of a shallow valley running east-west across New Providence Island. Cloud forms rapidly over the ridge throughout the year after about 0900 E.S.T., irrespective of the direction of the wind in the lowest layers. Out of the 540 cases examined between July 1, 1946, and December 31, 1947, there were only 87 occasions in which a height of 18,000 ft. was reached at 1000 E.S.T.

Unless the cloud formation is typically stratocumulus in character there is normally a decrease of cloud towards 1600 E.S.T. There is a minimum cloudiness over the island around dawn and, during the summer months, ascents are taken between 0500 and 0600 E.S.T. whenever possible. The number of ascents up to or above 25,000 ft. during the period October 1946 to December 1947 were 48 at 1000, 50 at 1600, and 12 at 0600 E.S.T.

Although haze is common in summer, this does not present any serious hazard to high-altitude ascents. The one exception, during 1947, was the day

PILOT-BALLOON ASCENTS AT NASSAU, BAHAMAS, BETWEEN DECEMBER 1946 AND DECEMBER 1947

Date	Dec. 19 1946		Feb. 17 1947		Feb. 20 1947		Feb. 23 1947		Feb. 27 1947	
Time (G.M.T.) ..	2100		2200		1500		2100		2100	
ft.	°	kt.	°	kt.	°	kt.	°	kt.	°	kt.
5,000	120	10	320	13	190	22	220	10	270	10
10,000	180	4	320	23	220	29	270	23	310	30
15,000	220	10	290	22	270	45	270	73	280	56
20,000	240	9	290	24	280	55	260	84	280	54
25,000	250	15	290	58	280	63			280	68
30,000	250	28	270	93					270	79
35,000	260	30							260	75
40,000	270	49								
45,000	270	62								
50,000	280	64								
55,000	270	158								
Maximum height (ft.)	57,370		33,445		28,809		20,773		39,237	
Maximum speed (kt.)	159		96		88		97		103	
Height (ft.)	55,150		30,200		27,200		20,773		39,237	
How lost	Low elevation		Low elevation		Low elevation		Low elevation		Low elevation	

Date	Mar. 5 1947		Mar. 24 1947		Oct. 23 1947		Nov. 5 1947		Dec. 24 1947	
Time (G.M.T.) ..	2200		2100		1600		2000		1500	
ft.	°	kt.	°	kt.	°	kt.	°	kt.	°	kt.
5,000	130	15	210	21	110	13	250	12	330	7
10,000	290	10	290	13	110	3	280	21	290	29
15,000	290	40	240	28	290	21	300	25	260	25
20,000	300	40	250	37	290	22	280	35	260	31
25,000	310	60	270	49	300	25	270	45	270	43
30,000	280	72	270	69	300	45	260	79	270	81
35,000	280	82	280	65	300	76	260	102	270	79
40,000	280	74	270	94	310	101	250	148	240	50
45,000	290	80					270	142		
50,000	280	118					260	153		
55,000										
Maximum height (ft.)	51,826		40,210		40,210		52,902		40,210	
Maximum speed (kt.)	128		94		101		171		88	
Height (ft.)	51,826		40,210		40,210		46,695		38,049	
How lost	Low elevation		Low elevation		In haze		Low elevation		Behind Cu	

before the September hurricane reached its nearest point to Nassau when it was impossible to follow a 100-gm. balloon higher than 9,000 ft. because of thick haze, there being little cloud present.

Sheets of cirrus, base 30,000–35,000 ft., present a greater difficulty in summer, being present almost daily, due to the cumulonimbus clouds over larger islands in the vicinity.

Between October 1946 and December 1947 there were 55 cases of ascents up to or above 35,000 ft., 27 cases of ascents up to or above 50,000 ft., and 5 cases of ascents up to or above 70,000 ft. The record ascent at Nassau was made on February 13, 1948, when a theoretical height of 79,280 ft. was reached.

In the table given for the ascents made at Piarco, it is to be noticed that there are no wind speeds greater than 35 kt. Because of the prevailing strong westerly upper current over Nassau in the winter months, winds far in excess of this figure have been measured on a number of occasions. Between October 1946 and December 1947 there were 32 cases of recorded winds equal to or greater than 50 kt. The highest wind speed recorded during this period was 171 kt. on November 5, 1947, at a height of 46,695 ft. The table opposite gives a selection of the ascents in which wind speeds of over 100 m.p.h. were recorded.

The best time of year for high-altitude ascents is during the winter months, particularly when an anticyclone is centred some 300–500 miles to the north or north-west. Unfortunately, few high-altitude ascents are possible when they are most needed during the approach of a hurricane in the summer months.

A. BEYNON

Nassau, Bahamas, March 18, 1948.

Formation of rain

It is now 15 years since Bergeron* suggested that the chief factor effecting the release of real precipitation, i.e. of precipitation of substantial intensity and containing moderate or large drops, is the difference in vapour pressure between ice and supercooled water. Neither Bergeron nor Findeisen—with whose name the theory is also associated—claimed that ice crystals are always necessary for the formation of rain. Bergeron in fact specified two other processes which might cause raindrops to form, viz. coalescence of droplets due to very intense electric fields and temperature differences between neighbouring cloud elements due to radiation effects. The contention of those who support the theory is that most substantial rainfalls are initiated by the co-existence of ice crystals and supercooled water drops.

Although a considerable amount of evidence can be adduced in favour of the theory it seems unlikely that we shall ever be able to obtain conclusive proof that it is correct. On the other hand one would think that if the theory were wrong it would not be difficult to accumulate evidence of numbers of occasions when substantial rainfall has occurred while the cloud tops were at a temperature well above the freezing point with no other clouds above them.

I have frequently heard it suggested that " it is well known that rain occurs in the tropics with the clouds wholly at temperatures above 0°C." but a search through the literature indicates that meteorologists who possess well documented

*BERGERON, T.; On the physics of cloud and precipitation. *P. V. Met. Un. geod., géophys. int., Lisbon*, 1933, p. 156.

evidence of this type must be very averse to publishing it. In fact I have found only two well substantiated reports of substantial rain with the cloud tops above 0°C. (viz. Heywood* and Kotsch†). It is of interest that both these rainfalls were from layer-type clouds.

It would be of considerable interest if meteorologists who are able to do so would forward to the Editor reports of substantial rain on occasions when aircraft observations indicated with certainty that the cloud tops were at temperatures above 0°C.

A. C. BEST

NOTES AND NEWS

The first telegraphic daily weather report

The date, August 31, 1948, marks an important anniversary in the history of weather science, namely the centenary of weather reporting by telegraphy. The following is a reproduction of a table which appeared in the *Daily News* on August 31, 1848:—

STATE OF THE WIND AND WEATHER

(The state of the weather for the next two months must have such important consequences that we have made arrangements with the Electric Telegraph Company for a daily report.)

AT NINE O'CLOCK YESTERDAY MORNING the wind and weather at the under-mentioned places were as follows:—

Chelmsford	W.	Fine	Manchester	SE.	Cloudy
Colchester	WSW.	Fine	Masborough	W.	Fine
Derby	NE. by N.	Fine	Newcastle	SSW.	Fine
Gloucester	ESE.	Fine	Newmarket	W.	Fine
Glasgow	SW.	Fine	Norwich	W.	Very fine
Gosport	WNW.	Fine	Normanton	SW. by S.	Very fine
Hertford	N.	Fine	Nottingham	W.	Fine
Hull	WSW.	Fine	Peterborough	NE.	Fine
Leeds	W.	Fine	Poole	W.	Fine
Leicester	W.	Fine	Portsmouth	WNW.	Fine
Leith	W.	Fine	Rugby	S.	Very fine
Lincoln	S.	Fine	Southampton	NW.	Fine
Liverpool	NW.	Fine	Yarmouth	W.	Fine
London	W.	Fine	York	NW.	Fine
Lowestoft	W.	Cloudy			

This brief report, giving only the wind direction and the weather at 29 places in England, was the modest beginning of the whole complex organization for weather reporting on which the modern science of forecasting depends. It was the first time in history that anyone had been able to obtain reasonably prompt information as to the weather conditions existing over a large area at the same hour. The collection of synchronous weather reports in this way led naturally to the construction of charts on which the space distribution of weather elements could be studied. The recognition of definite weather systems, and of the fact that changes of weather were mostly associated with the movement of such systems, inevitably followed and scientific weather forecasting thus became a possibility.

The telegraphic weather reports appeared daily in the *Daily News* until October 30, 1848, and were then suspended. They had been very much

*HEYWOOD, G. S. P.; Rain formation in the tropics. *Quart. J. R. met. Soc., London*, **66**, 1940, p. 46.

†KOTSCH, W. J.; An example of colloidal instability of clouds in tropical latitudes. *Bull. Amer. met. Soc., Lancaster Pa.*, **28**, 1947, p. 87.

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RUBBER-DINGHY ROWING FROM THE *Weather Recorder*, APRIL 1948

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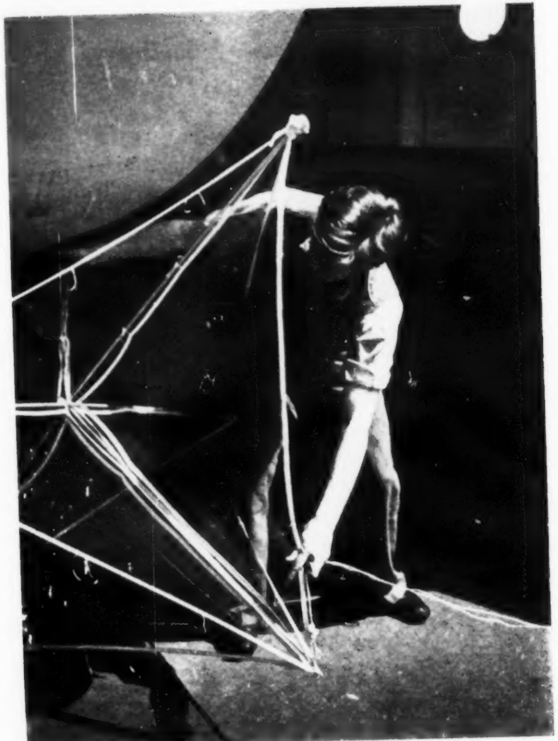

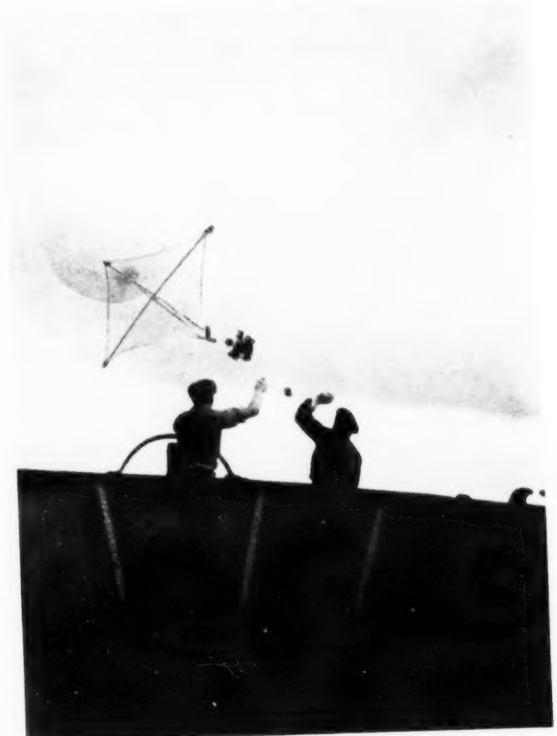

ASSEMBLING AND LAUNCHING A RADIO-SONDE BALLOON FROM AN OCEAN WEATHER SHIP

ASSEMBLING AND LAUNCHING A RADIO-SONDE BALLOON FROM AN OCEAN WEATHER SHIP

appreciated and there was a considerable public demand for their resumption. Among those who pressed for their reappearance was the Astronomer Royal, and in a leading article published on March 17, 1849, the newspaper made the welcome announcement that arrangements had been made with the co-operation of the Astronomer Royal and certain railway companies to resume the reports on a new and improved basis. The technical supervision of the scheme was entrusted to James Glaisher, Superintendent of the Magnetic and Meteorological Department at Greenwich Observatory, and it was planned to include reports from over fifty stations. Under Glaisher's enthusiastic direction, the reports were made accurately and promptly from well selected sites, and synoptic meteorology—to use the modern term—was thus set going in Great Britain.

Glaisher was one of the most distinguished figures in meteorology during the Victorian era. Born in 1809, he joined the staff of Greenwich Observatory in 1835 and became Superintendent of the Magnetic and Meteorological Department on its creation in 1840. Among many original contributions to meteorology special mention must be made of his " Hygrometrical Tables ", published in 1847, which were for many years the standard tables for the computation of humidity from readings of dry- and wet-bulb thermometers. During the years 1862–6 he made a large number of balloon ascents with the aeronaut Henry Coxwell to study the meteorology of the upper air. The most famous of these ascents was made from Wolverhampton on September 5, 1862, when the great altitude of about 7 miles was reached. Glaisher became insensible at 29,000 ft., and Coxwell's hands became so frozen that he was only able to open the valve by seizing the cord with his teeth and dipping his head.

The public spirit and lofty scientific ideals which inspired the proprietors of the *Daily News* in their pioneer effort of a hundred years ago are eloquently expressed in the leader of March 17, 1849:—

" It is scarcely necessary to point out the scientific importance of such reports. Though much has been done of late years to throw light upon the theory of the laws which regulate storms and atmospheric phenomena in general, much remains to be done. . . . The results of the knowledge which must thus be acquired will possess a high practical utility as well as philosophical interest, for it is impossible to conjecture beforehand the extent to which navigation, horticulture, agriculture, and even mechanical processes of manufacture, may be benefited by juster views and more extended knowledge of meteorological science."

E. G. BILHAM

Old meteorological prints

Mr. C. E. Britton is well known for his researches into historical references to the weather which occur in early literature. As a counterpart to these studies Mr. Britton has made a collection of old documents and prints of a meteorological character and has generously presented them to the Meteorological Office. Eight of the most interesting have been framed and now decorate the walls of the Conference Room in Victory House.

Six of the pictures are old prints depicting the Thames frozen over during the severe winters of 1683, 1739–40, 1789 and 1814. The first of these is the winter which is described so vividly in " Lorna Doone ". On the second

and fourth dates mentioned we see the frozen river covered with the booths and other paraphernalia which constituted the " Frost Fairs ". Some of the prints bear statements which show that they were actually printed on the ice. St. Paul's Cathedral and the Monument are conspicuous features on some of the pictures; but it is interesting to see in 1683 the Old London Bridge with its houses, whilst the later prints show the London Bridge as we know it.

In a pair of frames are to be seen two Royal Proclamations of King Charles I. The first, dated January 8, 1661, commands a " General and Public Fast to be kept throughout this whole Kingdom ", and exhorts the people to prayers for less severe weather. The second Proclamation, dated June 7 of the same year, refers to the " great and immoderate Rains and Waters that have lately faln in the Land " and commands the observance of a similar " religous exercise ".

Visitors to Victory House should make a point of seeing these very interesting pictures and documents which the generosity and zeal of Mr. Britton have placed in our possession.

N. K. JOHNSON

Seventy-five years of rainfall recording

The death on January 19, 1948, of Mr. John D. Walker of Ruddington, near Nottingham, at the age of 91, removes from the ranks of rainfall observers an enthusiast who broke all previous records by maintaining continuous observations over no less than three-quarters of a century.

Mr. Walker personally wrote out his rainfall return for 1947 and sent it to the Meteorological Office at Harrow less than a fortnight before his death. In a letter—written in a remarkably bold hand for a nonagenarian—he expressed his satisfaction in completing 75 years of daily recording in the Nottingham district but was fearful that owing to infirmities consequent upon age the observations might have to be discontinued. Mr. Walker sent his records to the British Rainfall Organization from 1873 to 1919, and to the Meteorological Office from 1920 onwards so that the 75 years' observations are preserved for posterity. The series is not strictly homogeneous as Mr. Walker changed his address three times during this long period.

So far as is known only three other observers have recorded meteorological observations for so much as 70 years. These were the Mackinnon of Mackinnon, who kept a rainfall record for 70 years at his seat Drumduan, near Forres, Morayshire, Sir John Eldon Bankes who observed at Soughton Hall in Flintshire, also for 70 years, and Sir John Moore who made observations in Dublin over a period of 73 years.

The late Mr. Walker was advised of these contemporary cases in a letter of congratulation regarding which his son writes:—

" My father was delighted and very proud to receive your letter and to know that he had created a record. He received the letter just after he was taken ill with what proved to be his last illness, but he showed me the letter with pride and remarked that he had never before been in such distinguished company. His rainfall record was a hobby of which he never tired. Even in his last days it kept cropping up in conversation. It is my intention to carry on the record if I can. I bear his exact name so we will see what we can do between us."

It is of interest to note that these four outstanding cases of notably long records were kept by an Englishman, a Scotsman, a Welshman and an Irishman, so that it may truly be said that honours are even.

H. E. CARTER

BOOKS RECEIVED

Jaarboek B. Aardmagnetisme (*Yearbook B. Geomagnetism*) 1945. Koninklijk Nederlands Meteorologisch Instituut, No. 98. Size: 13½ in. × 9½ in., pp. v + 26. 's-Gravenhage. Price 1·55 *florins*.

Summary of the meteorological observations made at the meteorological stations in the Netherlands West Indies during the year 1939, compiled by the Netherlands Meteorological Institute. Size: 9½ in. × 6¾ in., pp. 8. 's-Gravenhage. Price 0·20 *florins*.

REVIEWS

La Foudre, by Charles Maurain. Collection Armand Collin, No. 248, 8vo, 7 in. × 5 in., pp. 215, *Illus.* Continental Publishers Ltd., London. Price 4*s.* 0*d.*

The author of this little book is Honorary Professor of Geophysics at the University of Paris. The book covers a wider field than its title suggests, for it is essentially a review of the present state of knowledge of the electricity of disturbed weather. The author, in his preface, states this to be the object of the book and presumably he adopted the title " La Foudre ", which means the " thunderbolt " as well as lightning, so as to make a more popular appeal.

The book starts with a couple of chapters on the general electrical properties of the atmosphere, both in quiet and disturbed weather, before introducing the more detailed account of the phenomena of thunderstorm electricity. Chapter III describes the various methods by which lightning has been studied and is followed by a good account of the main results. The structure of thunderclouds and the theories of generation of electricity in them are then discussed as well as the theories of the mechanism of the lightning discharge, including, of course, the important work of Schonland, Loeb and Meek. Some pages are devoted to the fundamental question of the maintenance of the earth's electric charge and there is also quite a good account of the work on atmospherics. A useful bibliography is included but very few illustrations are provided. There is a list of contents but an index would have been more useful.

There are one or two statements in the book which may not be readily accepted. For example on page 21 Professor Maurain distinguishes between heat thunderstorms and frontal thunderstorms and says that the former are the less violent. This might well be questioned unless the violence is measured by the frequency of lightning flashes to earth, for in heat storms these are relatively less frequent than in frontal storms. Again, on page 91, it is stated, quite correctly, that a field of 30,000 v./cm. is required to produce a spark in air at ordinary pressure but the author goes on to say that this value is attained at the place where a lightning discharge commences. Macky's experiments in 1931, however, showed that in a thundercloud the presence of small water drops, in addition to the lower pressure, makes the critical value of the field at which breakdown occurs of the order of 10,000 v./cm.

This book is rather similar in scope to Schonland's monograph on "Atmospheric Electricity " which was published 16 years ago. The subject

has advanced considerably since then and there was a need for a more up-to-date survey. Professor Maurain has provided a very readable and comprehensive account of the subject and has, indeed, done exceedingly well to compress so much detailed information into such a small volume. Owing, evidently, to the poor exchange of scientific information during and just after the war he has, apart from a footnote or two added at the proof stage, not included any work more recent than 1943. There is, for example, no mention of Chalmer's work on various problems of thunderstorm electricity, of Frenkel's adsorption theory of the electrification of water drops and ice particles or of the work on lightning currents by Stekolnikov and by Bruce and Golde. Neither is there any mention of the possibilities of radar as a means of investigating thunderstorms, but it would be asking rather a lot to expect such a small book to cover as recent a development as this. However, despite these omissions, which will only be missed by the specialists, the general reader will find this book presents a good and easily understandable survey of the main methods, results and theories of the electrical phenomena associated with stormy weather.

F. J. SCRASE

Le climat écologique de la cuvette centrale Congolaise, by Étienne Bernard. Publication de l'Institut National pour l'étude agronomique du Congo Belge, 8vo. 11¼ in. × 8¾ in., pp. 240. *Illus.* Marcel Hayez, Brussels, 1945, Price: 300 *fr.*

This book deals with the general ecological climate of the central Congo basin, which is defined as the land below 500 m. between the parallels of 4°N. and 4°S., and the meridians of 16° and 26°E. The whole of this region is covered with equatorial rain-forest and the climate is discussed from standard observations at a few widely scattered stations. However, the climate, which is best described as equatorial continental, is remarkably homogeneous, and it is therefore legitimate to generalise from few data.

A large part of the volume is devoted to a discussion of the usual climatic elements, including humidity and evaporation. Although the ecological significance of each element is emphasised, most of the text, tables and diagrams are of great value to anybody studying the climatology of the region. We learn, for example, that the diurnal variation of rainfall shows a principal maximum between midnight and dawn, and only a secondary maximum in the afternoon, a result which is based on observers' notes and which it would be interesting to have confirmed by autographic records.

One of the most interesting features of the book is a chapter on radiation. The author admits the paucity of his observations, but makes good use of the material at his disposal and presents many facts in a new light. To give but one example, he points out that life on the earth is possible only because atmospheric ozone absorbs all the strongly antibiotic ultra-violet rays of wave-length less than 0·28 μ.

There is a comprehensive bibliography at the end of the book which deals with both general, ecological and meteorological topics and also with the climatology of central Africa.

In the introduction to the volume it is mentioned that more detailed investigations are to be carried out. It is to be hoped that it will not be too long before the present stimulating publication is continued by a work dealing with the microclimates of the equatorial forest and its clearings.

W. H. HOGG

On the kinematic structure of transition layers between air masses, by P. Groen, *Meded. Verh. Ned. Inst., De Bilt*, Serie B., Deel 1, Nr. 6. 4to. 12½ in. × 9 in. pp. 8. Rijksuitgeverij/'s-Gravenhage, 1947. Price: 1 *florin*.

This short note by Dr. Groen analyses the structure of a frontal transition zone by eliminating ρ, the density, in favour of θ, the potential temperature of the air. By this means he derives an expression for the slope of a front and a relation between velocity parallel to the front and potential temperature. He also examines the effect of viscosity and evaluates what he calls the "anti-viscosity gradient", being the gradient necessary to counterbalance viscosity without leading to any motion of the front. It may amount to as much as 1 mb./1,000 Km.

Whilst this analysis is applicable to more general cases and the solution of the viscosity problem is very neat, so far as it goes, it still makes no allowance for the equally important vertical motion and the more important acceleration effects. With these limitations it provides a useful transformation of Margules' formula and extends it to most practical distributions of velocity and potential temperature.

P. B. SARSON

ERRATUM

September 1948, PAGE 205, paragraph 4.—Potato blight is caused by a fungus, not by a virus. Study of the microclimate of the potato field is important both for the insect-borne virus diseases such as "leaf roll" and the fungus diseases.

WEATHER OF AUGUST 1948

During the first two days of the month pressure was rather uniform and nearly normal over the British Isles. A ridge of relatively high pressure moved eastwards across the country on the 4th. Depressions soon advanced from the Atlantic, and there was no steady anticyclonic period until after the 26th. The most notable depression was centred near Brest on the evening of the 7th, when pressure was as low as 969 mb. at its centre; it moved north-eastwards across south-east England during the night of the 7th and forenoon of the 8th. A shallower disturbance moved north-eastwards across central England during the 11th and the early hours of the 12th, while a third crossed southern Scotland in the early hours of the 16th. A quieter period followed, until a rapidly deepening depression approached the south-west coast of Ireland during the night of the 20th, turning northwards on the 21st and then eastwards along the sixtieth parallel to reach southern Norway on the evening of the 24th. Yet another deep depression moved east-north-east across southern Scotland on the afternoon of the 25th. This was followed by an anticyclone which covered the British Isles on the 27th and 28th, its north-west flank remaining over south-east England to the end of the month.

The map of mean pressure for the month shows the usual anticyclone over the Azores, with pressure above 1020 mb., and mean pressure about 1015 mb. over most of the eastern part of the U.S.A., central and southern Europe, and the Mediterranean. A region with mean pressure slightly below 1010 mb. extended from the north-west of Russia across Scandinavia and Scotland at least as far as longitude 20°W. Pressure was one or two millibars below the normal over most of Europe, and not far from normal over the eastern part of the U.S.A., and around Iceland and the Azores.

The weather over the British Isles was unsettled, dull and wet, with heavy rain storms causing severe floods in some areas.

The warm weather experienced at the end of July continued over August 1, the thunderstorm area shifting north. On the 2nd a shallow trough of low pressure stretching from Denmark to France extended its influence over England giving widespread thunderstorms associated with heavy local rain; 3·94 in. was measured at Silsoe, Bedfordshire, 3·44 in. at Cranham, Gloucestershire, and 3·02 in. at Bridgend, Glamorgan. Meanwhile a current of polar air moved south over Scotland and temperature fell, first in the north and by the 3rd over the whole country. From the 4th to the 6th troughs of low pressure moved north-east over England giving rain in most areas except the north of Scotland. On the 7th a vigorous secondary depression approached south-west England and subsequently moved north-east across southern England to the south of Norway. Gales occurred in the English Channel and along the south coast on the night of the 7th–8th and considerable rain fell except in the north of Scotland. On the 10th a shallow depression moved south-east to the Bristol Channel and later turned north-east across England to the southern North Sea. Heavy thundery rains occurred in the Midlands and north-east England on the 11th and in Northumberland and the Border counties on the 12th causing heavy damage and flooding in those areas (Kelso, Roxburgh, had 6·21 in. and Belford, Northumberland, 4·35 in.). At Kelso the river Tweed rose 6½ in. higher than in the previous highest flood of 1831. On the 15th and 16th another disturbance moved slowly east across the north of Ireland and south Scotland; further appreciable rain occurred in the north but there was little or none in the south. From the 21st to the 24th a depression off south-west Ireland moved north to southward of Iceland and then east across the north of Scotland to southern Scandinavia where it filled. There were local gales in the west and north and further rain. On the 23rd a shallow secondary moved east-north-east along the English Channel. On the 25th a new deep depression west of Scotland moved rather quickly east-north-east and was associated with local gales on its southern side and appreciable rainfall in the north and west. In the rear of this disturbance a ridge of high pressure moved in from the west over the British Isles and intensified. Later it continued moving east to the North Sea and mainly fair weather persisted over England until the 31st. On the 28th and 29th a trough moving east over our north-west districts gave further rain in the north and west. On the last day a trough of low pressure moved east over the country giving general rain, heavy in the west.

The general character of the weather is shown by the following table:—

	Air Temperature			Rainfall		Sunshine	
	Highest	Lowest	Difference from average daily mean	Percentage of average	No. of days' difference from average	Percentage of average	Percentage of possible duration
	°F.	°F.	°F.	%		%	%
England and Wales	83	37	−0·9	134	+1	73	28
Scotland	78	29	−1·1	159	0	64	18
Northern Ireland..	73	38	−0·2	96	+3	74	22

RAINFALL OF AUGUST 1948

Great Britain and Northern Ireland

County	Station	In.	Per cent of Av.	County	Station	In.	Per cent of Av.
London	Camden Square	3·02	137	*Glam.*	Cardiff, Penylan	5·65	134
Kent	Folkestone, Cherry Gdns.	3·52	147	*Pemb.*	St. Ann's Head	3·79	114
,,	Edenbridge, Falconhurst	5·23	200	*Card.*	Aberystwyth	6·15	160
Sussex	Compton, Compton Ho.	4·79	155	*Radnor*	Bir. W. W., Tyrmynydd	4·94	92
,,	Worthing, Beach Ho.Pk.	3·99	177	*Mont.*	Lake Vyrnwy	7·31	142
Hants	Ventnor, Roy. Nat. Hos.	3·99	201	*Mer.*	Blaenau Festiniog	12·78	114
,,	Bournemouth	3·44	137	*Carn.*	Llandudno	2·72	97
,,	Sherborne St. John	4·27	176	*Angl.*	Llanerchymedd	3·48	96
Herts.	Royston, Therfield Rec.	4·13	161	*I. Man.*	Douglas, Boro' Cem.	5·72	150
Bucks.	Slough, Upton	2·76	127	*Wigtown*	Port William, Monreith	3·52	91
Oxford	Oxford, Radcliffe	3·43	150	*Dumf.*	Dumfries, Crichton R.I.	7·63	189
N'hant.	Wellingboro', Swanspool	2·31	97	,,	Eskdalemuir Obsy.	10·00	194
Essex	Shoeburyness	2·89	163	*Roxb.*	Kelso, Floors	10·46	355
Suffolk	Campsea Ashe, High Ho.	3·18	161	*Peebles*	Stobo Castle	7·21	203
,,	Lowestoft Sec. School	2·90	132	*Berwick*	Marchmont House	9·57	289
,,	Bury St. Ed., Westley H.	4·10	158	*E. Loth.*	North Berwick Res.	8·02	254
Norfolk	Sandringham Ho. Gdns.	2·60	96	*Midl'n.*	Edinburgh, Blackf'd. H.	9·40	293
Wilts.	Bishops Cannings	2·93	95	*Lanark*	Hamilton W. W., T'nhill	6·09	178
Dorset	Creech Grange	3·90	136	*Ayr*	Colmonell, Knockdolian	3·53	88
,,	Beaminster, East St.	5·53	177	,,	Glen Afton, Ayr San	7·23	134
Devon	Teignmouth, Den Gdns.	2·72	120	*Bute*	Rothesay, Ardencraig	7·71	158
,,	Cullompton	3·92	129	*Argyll*	L. Sunart, Glenborrodale	5·95	105
,,	Barnstaple, N. Dev. Ath.	4·05	123	,,	Poltalloch	3·44	70
,,	Okehampton, Uplands	3·90	92	,,	Inverary Castle	9·75	148
Cornwall	Bude School House	3·16	112	,,	Islay, Eallabus	5·62	129
,,	Penzance, Morrab Gdns.	3·96	125	,,	Tiree	3·96	94
,,	St. Austell, Trevarna	3·65	101	*Kinross*	Loch Leven Sluice	8·06	210
,,	Scilly, Tresco Abbey	3·11	113	*Fife*	Leuchars Airfield	5·67	184
Glos.	Cirencester	3·56	119	*Perth*	Loch Dhu	11·45	170
Salop.	Church Stretton	3·07	92	,,	Crieff, Strathearn Hyd.	7·56	180
,,	Cheswardine Hall	3·90	117	,,	Blair Castle Gardens	..	..
Staffs.	Leek, Wall Grange P.S.	4·51	124	*Angus*	Montrose, Sunnyside	5·50	197
Worcs.	Malvern, Free Library	4·75	164	*Aberd.*	Balmoral Castle Gdns.	5·73	189
Warwick	Birmingham, Edgbaston	4·39	162	,,	Dyce, Craibstone	4·52	149
Leics.	Thornton Reservoir	3·95	141	,,	Fyvie Castle	5·18	163
Lincs.	Boston, Skirbeck	3·68	154	*Moray*	Gordon Castle	7·04	222
,,	Skegness, Marine Gdns.	4·41	181	*Nairn*	Nairn, Achareidh	4·77	196
Notts.	Mansfield, Carr Bank	3·40	122	*Inv's*	Loch Ness, Foyers	8·63	282
Ches.	Bidston Observatory	2·36	77	,,	Glenquoich	7·90	96
Lancs.	Manchester, Whit. Park	4·00	116	,,	Fort William, Teviot	8·51	137
,,	Stonyhurst College	4·68	92	,,	Skye, Duntuilm	5·55	125
,,	Blackpool	3·66	102	*R. & C.*	Ullapool	3·32	97
Yorks.	Wakefield, Clarence Pk.	3·73	143	,,	Applecross Gardens	6·08	129
,,	Hull, Pearson Park	3·47	119	,,	Achnashellach	6·08	96
,,	Felixkirk, Mt. St. John	3·19	112	,,	Stornoway Airfield	3·79	101
,,	York Museum	3·77	150	*Suth.*	Lairg	3·71	117
,,	Scarborough	2·61	94	,,	Loch More, Achfary	5·58	96
,,	Middlesbrough	3·63	132	*Caith.*	Wick Airfield	2·94	107
,,	Baldersdale, Hury Res.	4·20	120	*Shet.*	Lerwick Observatory	2·17	72
Norl'd.	Newcastle, Leazes Pk.	4·65	165	*Ferm.*	Crom Castle	4·11	99
,,	Bellingham, High Green	5·66	160	*Armagh*	Armagh Observatory	3·50	97
,,	Lilburn Tower Gdns.	7·84	278	*Down*	Seaforde	4·50	120
Cumb.	Geltsdale	6·14	149	*Antrim*	Aldergrove Airfield	2·89	80
,,	Keswick, High Hill	6·62	127	,,	Ballymena, Harryville	3·31	78
,,	Ravenglass, The Grove	3·94	86	*Lon.*	Garvagh, Moneydig	3·85	98
Mon.	Abergavenny Larchfield	4·79	161	,,	Londonderry, Creggan	4·72	102
Glam.	Ystalyfera, Wern House	9·39	152	*Tyrone*	Omagh, Edenfel	4·02	94

CLIMATOLOGICAL TABLE FOR THE BRITISH COMMONWEALTH, APRIL 1948

Stations	Pressure		Temperatures							Relative humidity	Mean cloud amount	Precipitation			Bright Sunshine	
	Mean of day M.S.L.	Diff. from normal	Absolute Max.	Absolute Min.	Mean values Max.	Mean values Min.	Mean values ½ Max. and Min.	Mean values Diff. from normal	Mean values Wet bulb			Total	Diff. from normal	Days	Daily Mean	Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	tenths	in.	in.		hr.	%
London, Kew Observatory	1012·8	−0·6	69	36	58·3	42·3	50·3	+3·2	46·2	69	5·8	1·24	−0·21	13	7·1	52
Gibraltar	1013·5	−2·9	74	51	68·5	56·1	62·3	+1·4	57·3	75	5·3	2·78	—	14	8·0	61
Malta	1013·8	+0·4	75	46	66·0	53·5	59·7	−1·2	57·4	72	5·3	0·76	—	6	9·5	73
St. Helena	1015·0	−0·4	74	59	71·0	61·7	66·3	+1·6	61·2	92	8·9	3·25	−0·22	17	—	—
Freetown, Sierra Leone	1010·6	+1·4	94	73	85·3	77·3	81·3	+0·1	75·7	78	5·6	2·32	−1·74	7	6·8	55
Lagos, Nigeria ..	1009·9	+0·5	94	66	89·5	71·3	80·4	−2·4	77·8	81	8·8	4·12	—	11	5·1	42
Kaduna, Nigeria ..	1007·6	—	97	64	91·5	71·0	81·3	−0·9	72·7	70	7·5	5·92	+2·84	7	7·4	60
Chileka, Nyasaland	1015·9	−0·3	86	60	80·9	64·4	72·7	+0·9	67·9	75	5·3	3·03	+1·63	8	6·8	58
Lusaka, Rhodesia ..	1013·3	−0·2	84	56	78·8	60·1	69·5	+0·6	63·9	78	5·9	0·72	−0·04	5	7·1	61
Salisbury, Rhodesia	1015·3	−0·2	81	52	76·0	56·6	66·3	+0·4	60·5	78	5·0	2·27	+1·20	6	7·2	61
Cape Town	1016·8	+0·4	103	46	74·4	55·6	65·0	+1·8	55·2	75	4·7	1·91	+0·04	12	—	—
Germiston, South Africa	1016·1	—	78	37	70·5	49·5	60·0	—	51·1	68	2·2	3·12	—	6	9·2	80
Mauritius	1013·9	0·0	88	66	82·9	71·4	77·1	+1·3	72·5	82	5·7	10·40	+5·28	21	6·8	59
Calcutta, Alipore Obsy.	1005·1	−0·3	99	71	95·2	77·5	86·3	+0·7	77·8	80	4·5	0·73	−1·45	5	9·7	77
Bombay	1008·2	−0·6	94	75	90·9	77·8	84·3	+1·2	76·7	77	2·8	0·00	−0·05	0	9·8	78
Madras	1008·3	−0·1	99	72	95·0	78·3	86·7	+1·4	77·8	75	5·1	0·44	−0·19	1	9·9	80
Colombo, Ceylon ..	1009·7	+1·0	90	72	87·8	75·4	81·6	−1·1	76·2	89	7·0	11·39	+1·66	20	7·8	63
Singapore	1009·0	+0·1	93	71	90·2	75·5	82·9	+1·3	77·6	81	5·7	4·26	−3·37	10	—	—
Hongkong	1012·5	−0·1	84	64	77·6	68·5	73·1	+2·3	69·3	86	—	6·07	+0·42	19	2·9	23
Sydney, N.S.W. ..	1017·6	−0·8	81	47	70·1	56·7	63·4	−1·3	57·3	72	5·0	1·38	−4·11	12	6·2	55
Melbourne	1018·9	−0·6	85	40	66·5	51·4	58·9	−0·6	53·0	71	7·6	3·37	+1·20	16	4·0	36
Adelaide	1020·3	+1·0	90	49	70·2	54·6	62·4	−1·5	55·4	63	7·7	4·66	+2·94	13	5·1	46
Perth, W. Australia	1017·7	−0·7	82	49	74·3	56·5	65·4	−1·4	57·9	57	4·0	2·19	+0·54	13	7·4	66
Coolgardie	1019·4	+1·1	84	41	71·0	52·1	61·5	−3·5	52·9	60	3·8	0·78	−0·18	5	—	—
Brisbane	1016·6	−1·0	87	52	76·8	59·9	68·3	−2·0	60·9	63	4·9	4·15	+0·38	12	7·2	63
Hobart, Tasmania	1018·4	+3·6	79	41	60·8	47·2	54·0	−1·2	49·5	74	7·7	2·27	+0·42	17	4·0	37
Wellington, N.Z. ..																
Suva, Fiji	1010·4	−0·2	85	68	83·4	72·5	77·9	−0·7	75·0	86	6·1	18·34	+6·13	17	6·7	57
Apia, Samoa ..	1010·1	+0·4	89	72	87·0	74·7	80·9	+0·7	77·5	80	7·3	12·34	+2·57	22	5·8	49
Kingston, Jamaica	1014·3	+0·2	91	67	88·0	71·4	79·7	+1·3	73·9	73	3·6	0·61	−0·63	5	9·7	78
Grenada, W. Indies	1013·3	+0·8	87	66	85·0	74·6	79·8	+0·9	74·7	75	7·5	0·65	−1·51	9	—	—
Toronto	1018·4	+2·3	71	25	54·8	38·0	46·4	+4·3	38·7	67	6·8	1·96	−0·33	11	5·9	44
Winnipeg	1015·1	−1·6	70	−5	43·7	26·8	35·3	−2·4	27·7	—	6·7	2·13	+0·73	12	5·9	43
St. John, N.B. ..	1017·4	+4·0	54	20	44·6	30·8	37·7	−1·3	33·3	78	6·4	4·50	+0·99	18	5·3	39
Victoria, B.C. ..	1013·0	−4·5	61	27	52·9	38·8	45·9	−2·0	39·2	90	6·7	1·55	+0·03	15	5·9	43